

Retinal development and light response in larval lake sturgeon

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Objectives

To characterize the development of the lake sturgeon visual system and associated response to light. These results may be useful for identifying an optimal light environment for the early life history stages of the lake sturgeon.

Methods

Rearing conditions: Fertilized lake sturgeon eggs from Black Lake MI were maintained in the laboratory at 13 degrees C on a 15:9 hour light dark cycle.

Histology: Samples were fixed in Bouin's for 3-5 days; embedded in Immunobed resin, sectioned at 3 microns and stained with cresyl violet.

Light Response: At daily intervals after hatching, larvae were tested for their phototactic response. The light source was a series of narrow bandwidth light emitting diodes (UV, visible, IR). Behavior was videotaped using IR illumination and an IR sensitive camera. Analysis was performed using iMovie.

Eye movements: Larvae were immersed in a dish of 3% methylcellulose and placed on a horizontal computer monitor playing a moving bar pattern. Eye movements were monitored using a dissection scope equipped with a videocamera.

Results

At hatching, the larvae elicited negative phototaxis (Figure 1); however, the retina was undifferentiated (Figure 2). The pineal organ does appear to be differentiated at time of hatching (Figure 3a, b) and likely facilitates the observed response to light. At 5 days post hatch (dph) cone photoreceptors were beginning to differentiate in the central retina (Figure 3c, d). The response to light also changed as the larvae became less photonegative, but instead they froze when the light source was turned on. Larvae responded to all wavelengths of light, but showed a diminished response with decreased light intensity (Figure 4 and 5). Eye movements were observed at 15 dph, but did not appear to be in response to our stimuli (Figure 6). At this time all retinal layers are differentiated (Figure 7).

Conclusions

Larval lake sturgeon prefer low light intensity. The initial response to light is not via the retina, but presumably the pineal organ. The larvae are responsive to a wide spectral range, including UV. Once developed, the larval lake sturgeon retina is sensitive to low light, but also has low visual acuity. Although sturgeon do elicit coordinated eye movements they did not respond to grating stimuli. Under natural rearing temperatures, vision is not likely functional prior to one week of age, but the light environment is clearly important.

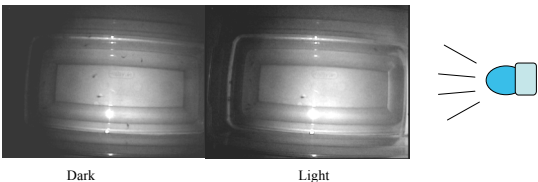


Figure 1: Immediately after hatching, larvae elicit a negative phototaxis. When light is presented on the right, the larvae cluster on the left side of the tank.

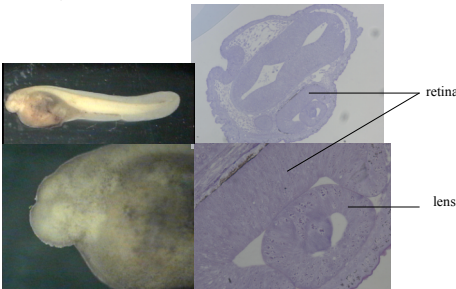


Figure 2: The larvae hatch without a functional eye. The eye cup has formed, but cells of both the retina and lens are undifferentiated.

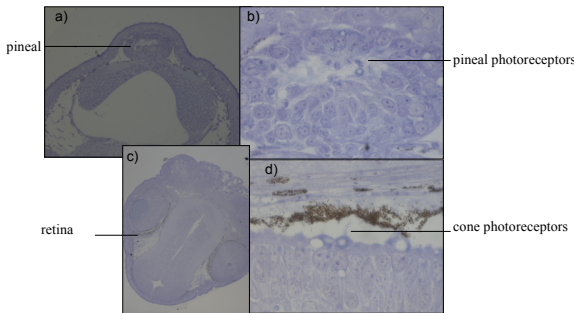
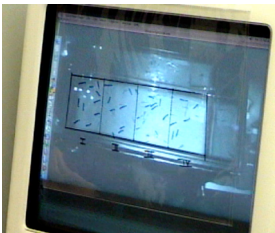


Figure 3: At 5 days post hatch, the pineal organ is well defined (top panels). Cone photoreceptors with oil droplets are beginning differentiation in the central retina (bottom panels).

Color	Wavelength (nm)	Intensity
UV	395	510
blue	470	5900
sea green	495	4400
green	515	6200
amber	585	5500
orange	605	4800
red	625	5000
infra-red	940	

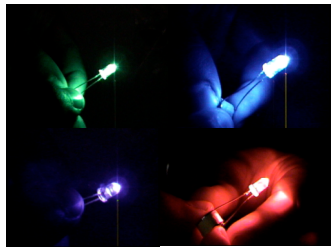


Figure 4: Lake sturgeon larvae swim constantly in the dark. When larvae were exposed to narrow bandwidth light (LED's) of varying wavelengths, they would stop swimming and remain motionless.

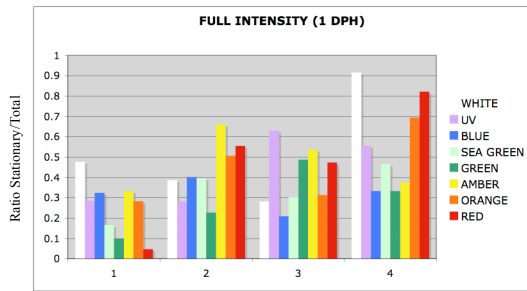


Figure 5: The response was scored as the number of stationary larvae relative to the total number in that quadrant of the tank. Larvae responded to light of all wavelengths with the response diminishing with increased distance from the light source and presumably decreased intensity.



Figure 6: Coordinated eye movements were initially observed at 15 dph, but the larvae did not show a strong response to moving grating patterns.

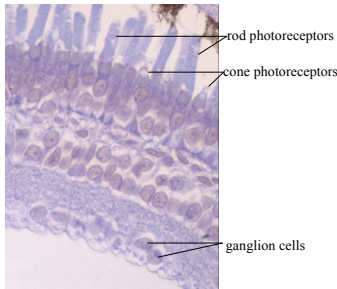


Figure 7: 65 dph Once complete, the retina has both rods and cones with low numbers of ganglion cells

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